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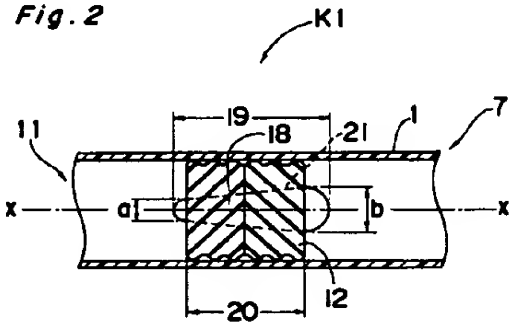
(54) Two-compartment type prefilled syringe

(57) A two-compartment type prefilled syringe (K1) including a first rubber stopper (6) fitted into a front sleeve (7), a second rubber stopper (9) fitted into a rear end portion of a cartridge (1), a third rubber stopper (12) for hermetically dividing interior of the cartridge (1) into front and rear compartments (14, 16) and a bypass (18) formed by radially outwardly bulging a portion of a peripheral wall of the cartridge (1), wherein in an axial direction of the cartridge (1), a length (20) of the third rubber stopper (12) is slightly smaller than an inner length (19) of the bypass (18), wherein when the third rubber stopper (12) has been displaced into the bypass (18), sealing property of the rear compartment (16) against the front compartment (14) is cancelled such that dissolving agent (15), suspension or the like in the rear compartment (16) is carried, via the bypass (18), into the front compartment (14) containing dry medicament (13) or the like, wherein a ratio (R) of a maximum width (b) of one end of the bypass (18) adjacent to the front sleeve (7) to a maximum width (a) of the other end of the bypass (18) adjacent to the rear end portion of the cartridge (1) is set to range from 1.2 to 5.0.

Fig. 2



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Description

BACKGROUND OF THE INVENTION

The present invention generally relates to a two-compartment type prefilled syringe in which interior of a cartridge made of glass or plastic is divided into front and rear compartments by a plurality of rubber stoppers and more particularly, to improvement of a bypass for communicating the front and rear compartments with each other, which is formed by bulging a peripheral wall of the cartridge radially outwardly.

A two-compartment type prefilled syringe having such a construction is known from, for example, Japanese Patent Laid-Open Publication No. 62-5357 (1987) and Japanese Utility Model Publication No. 3-31302 (1991). In the known two-compartment type prefilled syringe disclosed in the former document, a first rubber stopper F disposed adjacent to a front sleeve L, a second rubber stopper D disposed adjacent to a finger grip N acting as an inlet for a plunger rod M and a third rubber stopper E disposed between the first and second rubber stoppers F and D are provided in a cartridge A made of glass or plastic as shown in Fig. 6. Interior of the cartridge A is hermetically divided into a front compartment C and a rear compartment B by the third rubber stopper E. The third rubber stopper E is constituted by a rear third rubber stopper E1 and a front third rubber stopper E2.

A bypass I for communicating the front and rear compartments C and B with each other is formed by radially outwardly bulging a portion of a peripheral wall of the cartridge A disposed between the first rubber stopper F and the third rubber stopper E.

In the known two-compartment type prefilled syringe having the construction shown in Fig. 6, the first rubber stopper F is displaced to a front end chamber Q2 through a front chamber Q1 at an initial stage of depression of the plunger rod M. By grooves R1 and R2 formed on an inner surface of a peripheral wall of the front end chamber Q2, the front chamber Q1 and the front end chamber Q2 are communicated with a bore P leading to an injection needle J. When the plunger rod M is further depressed, the second rubber stopper D is advanced and thus, the third rubber stopper E is pushed towards the front compartment C by internal pressure of pharmaceutical liquid such as dissolving agent H filled in the rear compartment B in liquid-tight condition.

At the moment the third rubber stopper E has been displaced into the bypass I, the rear compartment B and the front compartment C are communicated with each other by a gap between the bypass I and the third rubber stopper E, so that the pharmaceutical liquid such as the dissolving agent H of the rear compartment H flows into the front compartment C at high velocity so as to suspend or dissolve dry medicament G. At an initial stage of communication between the rear compartment B and the front compartment C, the pharmaceutical liquid such as the dissolving agent H, which has passed through the bypass I, has high kinetic energy and thus, impinges like a squirt upon a rear face of the first rubber stopper F in the front end chamber Q2. As a result, the pharmaceutical liquid such as the dissolving agent H flows into the grooves R1 and R2 of the front end chamber Q2 so as to suspend the dry medicament G sufficiently or reach the injection needle J from the bore P without dissolving the dry medicament G.

Meanwhile, the front third rubber stopper E2 is fitted into the cartridge A from the front chamber Q1 for the purpose of sealing the rear compartment B and the front compartment C in liquid-tight condition and preventing transfer of moisture to the dry medicament G of the front compartment C from the rear third rubber stopper E1 which has absorbed moisture by steam sterilization performed after pour and sealing of the pharmaceutical liquid such as the dissolving agent H.

On the other hand, in the conventional two-compartment type prefilled syringe disclosed in the latter document, a gasket S disposed adjacent to a finger grip Y confronting a plunger rod (not shown) is fitted into a peripheral wall of a cartridge K, while a first rubber stopper W is fitted into a front sleeve V as shown in Fig. 7. Furthermore, a third rubber stopper R3 is fitted into the peripheral wall of the cartridge K so as to be disposed between the gasket S and the first rubber stopper W. Interior of the cartridge K is divided into a front compartment Q3 and a rear compartment Q4 by the third rubber stopper R3. The dry medicament G is filled in the front compartment Q3, while the dissolving liquid H is filled in the rear compartment Q4. A bypass T for communicating the front compartment Q3 and the rear compartment Q4 with each other is formed by radially outwardly bulging a portion of the peripheral wall of the cartridge K disposed between the first rubber stopper W and the third rubber stopper R3. A concave engageable portion P1 and a convex engageable portion P2 are, respectively, formed on a rear face of the third rubber stopper R3 and a front face of the second rubber stopper S so as to confront each other. When the rear face of the third rubber stopper R3 and the front face of the second rubber stopper S have been brought into contact with each other, the convex engageable portion P2 of the second rubber stopper S is brought into engagement with the concave engageable portion P1 of the third rubber stopper R3 so as to couple the second and third rubber stoppers S and R3 with each other integrally.

Prior to use of the conventional two-compartment type prefilled syringe of Fig. 7, a double-pointed needle (not shown) is mounted on the front sleeve V so as to pierce the first rubber stopper W. Subsequently, when the second rubber stopper S is advanced by the plunger rod screwed into a threaded portion of the second rubber stopper S, internal pressure of the dissolving agent H of the rear compartment Q4 rises, so that the third rubber stopper R3 is advanced into the bypass T. At the moment the rear compartment Q4 and the front com-

partment Q3 have been communicated with each other, the dissolving agent H having high kinetic energy is drawn into the front compartment Q3 like a squirt so as to reach the first rubber stopper W.

At the time a whole amount of the dissolving agent H in the rear compartment Q4 has displaced to the front compartment Q3, the second rubber stopper S is brought into contact with the third rubber stopper R3. Therefore, the convex engageable portion P2 of the second rubber stopper S is brought into engagement with the concave engageable portion P1 of the third rubber stopper R3 so as to couple the second and third rubber stoppers S and R3 with each other integrally.

In both of the prior art two-compartment type prefilled syringes of Figs. 6 and 7, an operation for delivering the pharmaceutical liquid such as the dissolving agent in the rear compartment to the front compartment containing the dry medicament is performed in a state in which the injection needle is fitted into the syringe. Therefore, such a drawback is incurred that since only the pharmaceutical liquid leaks out of the injection needle prior to suspension or dissolution of the dry medicament due to the above mentioned squirt phenomenon of the pharmaceutical liquid such as the dissolving agent, amount of the dissolving agent is less than that required for dissolving the dry medicament in the front compartment, thereby resulting in improper dissolution of the dry medicament.

Meanwhile, in order to prevent the above mentioned squirt phenomenon of the pharmaceutical liquid, an operator should adjust depression of the plunger rod sophisticatedly, thus resulting in such a disadvantage that it is extremely difficult to operate the syringe.

Furthermore, only one measure for preventing the squirt phenomenon in the constructions of the prior art two-compartment type prefilled syringes is to increase volume of the front compartment to an unnecessary degree. Therefore, there has been a demand for a means for preventing the squirt phenomenon without incurring increase of volume of the front compartment.

In addition, it is not preferable that prior to injection, the dissolving agent adheres to an outer side of the injection needle and an inner side of a cap Z (Fig. 6) by the squirt phenomenon.

SUMMARY OF THE INVENTION

Accordingly, an essential object of the present invention is to provide, with a view to eliminating the above mentioned disadvantages of prior art two-compartment type prefilled syringes, a two-compartment type prefilled syringe in which a size of one end of a bypass adjacent to a rear end portion of a cartridge is minimized and a size of the other end of the bypass adjacent to a front end portion of the cartridge, i.e., a size of a path leading to a front compartment is increased so as to maximize an area of a gap defined by the other end of the bypass and a third rubber stopper and in which vigor of dissolving agent carried into the bypass by pressure in a rear compartment upon depression of a plunger rod is greatly diminished by increase of area of the bypass so as to cause the dissolving agent to flow slowly such that not only a risk that the dissolving agent is drawn into an injection needle together with air in the front compartment like a squirt is eliminated but a required amount of the dissolving agent is slowly carried into the front compartment by minimizing amount of the dissolving agent left in the bypass after administration of injection liquid.

In order to accomplish this object of the present invention, a two-compartment type prefilled syringe according to the present invention comprises: a cartridge; a front sleeve which is mounted on a front end portion of the cartridge and has an injection needle mounted thereon; a first rubber stopper which is fitted into the front sleeve and is pierced through by the injection needle prior to use of the prefilled syringe; a second rubber stopper which is fitted into a rear end portion of the cartridge; a plunger rod which is attached to the second rubber stopper; a third rubber stopper which is fitted into the cartridge so as to be disposed between the first rubber stopper and the second rubber stopper such that interior of the cartridge is hermetically divided into a front compartment defined between the first rubber stopper and the third rubber stopper and a rear compartment defined between the third rubber stopper and the second rubber stopper; and a bypass which is formed by radially outwardly bulging a portion of a peripheral wall of the cartridge disposed between the first rubber stopper and the third rubber stopper;
wherein in an axial direction of the cartridge, a length of the third rubber stopper is slightly smaller than an inner length of the bypass; wherein when the third rubber stopper has been displaced into the bypass, sealing property of the rear compartment against the front compartment is cancelled such that dissolving agent, suspension or the like in the rear compartment is carried, via the bypass, into the front compartment containing dry medicament or the like; wherein a ratio of a maximum width of one end of the bypass adjacent to the front sleeve to a maximum width of the other end of the bypass adjacent to the rear end portion of the cartridge is set to range from 1.2 to 5.0.

BRIEF DESCRIPTION OF THE DRAWINGS

This object and features of the present invention will become apparent from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 is a sectional view of a two-compartment type prefilled syringe according to a first embodiment of the present invention;

Fig. 2 is a schematic top plan view showing a bypass of the prefilled syringe of Fig. 1;

Fig. 3 is a view similar to Fig. 2, particularly showing its first modification;

Fig. 4 is a view similar to Fig. 2, particularly showing its second modification;

Fig. 5 is a schematic sectional view of a bypass of a two-compartment type prefilled syringe according to a second embodiment of the present invention;

Fig. 6 is a schematic sectional view of a prior art two-compartment type prefilled syringe; and

Fig. 7 is a schematic sectional view of a further prior art two-compartment type prefilled syringe.

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout several views of the accompanying drawings.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 shows a two-compartment type prefilled syringe K1 according to a first embodiment of the present invention. A bypass 18 of the prefilled syringe K1 is structurally identical with that of a prior art two-compartment type prefilled syringe of Fig. 6. A front sleeve 7 has an inside diameter slightly larger than an outside diameter of a cartridge 1 and is fitted around a front open end 2 of the cartridge 1. A needle base 5 provided with a cap 4 for protecting an injection needle 3 is mounted on a distal end 17 of the front sleeve 7 such that the needle base 5 is communicated with the front sleeve 7 at the distal end 17.

A first rubber stopper 6 is fitted into a peripheral wall of the cartridge 1 in liquid-tight condition in the vicinity of the front sleeve 7, while a second rubber stopper 9 is fitted into the peripheral wall of the cartridge 1 in liquid-tight condition at a finger grip 11 acting as an inlet for a plunger rod 10. A third rubber stopper 12 is fitted into the peripheral wall of the cartridge 1 so as to be disposed between the first rubber stopper 6 and the second rubber stopper 9 and includes a front third rubber stopper 12a and a rear third rubber stopper 12b.

Interior of the cartridge 1 is hermetically divided by the third rubber stopper 12 into a front compartment 14 defined between the first rubber stopper 6 and the third rubber stopper 12 and a rear compartment 16 defined between the second rubber stopper 9 and the third rubber stopper 12. Medicament such as dry medicament 13 is filled into the front compartment 14, while pharmaceutical liquid such as dissolving agent 15 and suspension is filled into the rear compartment 16. A bypass 18 is formed by radially outwardly bulging a portion of the peripheral wall of the cartridge 1 disposed between the first rubber stopper 6 and the third rubber stopper 12.

In an axial direction of the cartridge 1 along the line x-x shown in Fig. 2, a length 19 of the bypass 18 is slightly larger than a length 20 of the third rubber stopper 12 as in prior art. Thus, when the third rubber stopper 12 has been displaced into the bypass 18, sealing property of the rear compartment 16 is cancelled and thus, the dissolving agent 15 or the suspension in the rear compartment 16 is carried into the front compartment 14 via the bypass 18.

In the present invention, flow velocity and state of flow of the dissolving agent 15 delivered to the front compartment 14 by way of the bypass 18 are changed according to shape of the bypass 18. As described below, shape of the bypass 18 is selected so as to prevent a phenomenon in which the dissolving agent 15 is discharged out of the injection needle 3 like a squirt. This phenomenon is referred to as a "squirt phenomenon" below.

In Fig. 2 showing the first embodiment, the cartridge 1 is oriented in the same direction as in Fig. 1. Therefore, the bypass 18 has a maximum width a at its one end adjacent to the finger grip 11 and a maximum width b at the other end adjacent to the front sleeve 7. A ratio of the maximum width b to the maximum width a is set to range from 1.2 to 5.0. Meanwhile, in the axial direction of the cartridge 1 along the line x-x in Fig. 2, the length 19 of the bypass 18 is set to be slightly larger than the length 20 of the third rubber stopper 12. Opposite side edges 21 of the bypass 18 connecting the opposite ends of the bypass 18 are formed rectilinearly.

In order to determine the maximum widths a and b of the opposite ends of the bypass 18 and the length 19 of the bypass 18 and the length 20 of the third rubber stopper 12 in the axial direction of the cartridge 1 along the line x-x in Fig. 2 as described above, the following experiments 1 to 7 were conducted so as to find out proper range of ratio R of the maximum width b to the maximum width a by observing flow of the dissolving agent 15 to the front compartment 14 via the bypass 18 at the time of depression of the plunger rod 10.

In the experiments, the maximum width a of the one end of the bypass 18 adjacent to the finger grip 11 was set at 2.0 mm and 5.0 mm and state of the dissolving agent 15 flowing into the front compartment 14 through the bypass 18 was observed by changing the maximum width b of the other end of the bypass 18 adjacent to the front sleeve 7. The experiments are aimed at minimizing the maximum width a of the one end of the bypass 18, eliminating the squirt phenomenon and minimizing amount of the dissolving agent 15 left in the bypass 18 after administration of injection liquid. Each experiment was conducted 10 times under the following conditions (i) to (iii).

(i) The cartridge 1 is made of glass subjected to silicone treatment and has an inside diameter of 14 mm.

(ii) The third rubber stopper 12 has a total width of 12 mm.

(iii) The plunger rod 10 is depressed at a speed of 15 cm/min.

Meanwhile, experimental results were classified

into four ranks in an ascending order of preference, i.e., a rank D that there is a strong possibility of leakage of the dissolving agent 15 from the injection needle 3 directly or through guide grooves of the cartridge 1, in which the dissolving agent 15 having passed through the bypass 18 impinges upon a rear face of the first rubber stopper 6 or a bottom of the front sleeve 7 vigorously in a stream, a rank C that there is a possibility of leakage of the dissolving agent 15 from the injection needle 3, in which the dissolving agent 15 flows into the front compartment 14 in a stream but feebly, a rank B that there is little possibility of leakage of the dissolving agent 15 from the injection needle 3, in which the dissolving agent 15 flows into the front compartment 14 at low velocity and a rank A that there is no possibility of leakage of the dissolving agent 15 from the injection needle 3, in which the dissolving agent 15 flows into the front compartment 14 at quite low speed and merely forms a slightly curved stream at an outlet of the bypass 18.

[1] Experiment 1 (a = 2.0 mm, b = 2.0 mm, R = 1.0)

(1) Rank D: 10

[2] Experiment 2 (a = 5.0 mm, b = 5.0 mm, R = 1.0)

(1) Rank D: 9
(2) Rank C: 1

[3] Experiment 3 (a = 2.0 mm, b = 2.4 mm, R = 1.2)

(1) Rank B: 8
(2) Rank A: 2

[4] Experiment 4 (a = 2.0 mm, b = 4.0 mm, R = 2.0)

(1) Rank B: 5
(2) Rank A: 5

[5] Experiment 5 (a = 2.0 mm, b = 8.0 mm, R = 4.0)

(1) Rank B: 3
(2) Rank A: 7

[6] Experiment 6 (a = 2.0 mm, b = 10.0 mm, R = 5.0)

(1) Rank A: 10

[7] Experiment 7 (a = 2.0 mm, b = 12.0 mm, R = 6.0)

(1) Rank A: 10

In the above experiments 1 to 7, as the value b becomes larger, amount of the dissolving agent 15 left in the bypass 18 after administration of the injection liquid also increases. Thus, especially in case the ratio R is 6.0 as in the experiment 7, the squirt phenomenon can be eliminated but amount of the dissolving agent 15 left in the bypass 18 after administration of the injection liquid is large, which is unsuitable for practical use.

From the above results, it is understood that when narrow gap of the bypass 18 is widened, namely, cross-sectional area of the bypass 18 is increased by gradual increase of width of a flow path from the maximum width a to the maximum width b of the bypass 18 at the time the dissolving agent 15 flows into the front compartment 14 via the bypass 18 upon depression of the plunger rod 10, flow velocity of a predetermined amount of the dissolving agent 15 delivered upon depression of the plunger rod 10 is reduced and thus, the dissolving agent 15 flows into the front compartment 14 slowly. It was confirmed in this case that the squirt phenomenon does not happen in which the dissolving agent 15 initially having passed through the bypass 18 flows through the front compartment 14 without dissolving the dry medicament 13 such as powdery medicament in the front compartment 14 and then, leaks out of the injection needle 3 together with air in the front compartment 14.

Fig. 3 shows a two-compartment type prefilled syringe K1' which is a first modification of the prefilled syringe K1. The prefilled syringe K1' includes a bypass 22. The bypass 22 has a maximum width c at its one end adjacent to the finger grip 11 and a maximum width d at the other end adjacent to the front sleeve 7. Opposite side edges 23 of the bypass 22 connecting the opposite ends of the bypass 22 are each formed by a gentle convex arc having a large radius R1.

In the prefilled syringe K1', a ratio of the maximum width d to the maximum width c is set to range from 1.2 to 5.0 and the length 19 of the bypass 22 is set to be slightly larger than the length 20 of the third rubber stopper 12 in the axial direction of the cartridge 1 in the same manner as the prefilled syringe K1.

Therefore, in the prefilled syringe K1', when the dissolving agent 15 flows into the front compartment 14 through the bypass 22, flow velocity of the dissolving agent 15 is reduced by increase of width of a flow path from the maximum width c to the maximum width d of the bypass 22 and each of the opposite side edges 23 of the bypass 22 is formed by the gentle arc having the large radius R1 so as to change cross-sectional area of the bypass 22 taken along a line orthogonal to the axial direction of the cartridge 1, more than the rectilinear side edges 21 of the bypass 18 of the prefilled syringe K1, the dissolving agent 15 flows through the bypass 22 slightly turbulently as compared with the rectilinear side edges 21 of the bypass 18 of the prefilled syringe K1, so that flow velocity of the dissolving agent 15 is further reduced than the prefilled syringe K1 and thus, the dissolving agent 15 flows into the front compartment 14 rather slowly.

Fig. 4 shows a two-compartment type prefilled syringe K1" which is a second modification of the prefilled syringe K1. The prefilled syringe K1" includes a bypass 24. The bypass 24 has a maximum width e at its

one end adjacent to the finger grip 11 and a maximum width f at the other end adjacent to the front sleeve 7. Opposite side edges 25 of the bypass 24 connecting the opposite ends of the bypass 24 are each formed by a gentle concave arc having a large radius R2 such that the bypass 24 has a gourdlike shape. However, even if the other end of the bypass 24 adjacent to the front sleeve 7 is formed into a mushroomlike shape, similar effects can be gained.

When the dissolving agent 15 passes through the bypass 24, flow of the dissolving agent 15 is made slightly turbulent by change of cross section of the flow path of the bypass 24 due to the gently concave side edges 25 of the bypass 24 and thus, flow velocity of the dissolving agent 15 is further reduced also by increase of ratio of the maximum width f to the maximum width e of the bypass 24.

In the prefilled syringes K1 to K1", flow velocity of the dissolving agent 15 is reduced not only by increase from the width of the one end of the bypass to that of the other end of the bypass but by change of cross section of the flow path of the bypass due to shape and bulging of the opposite side edges of the bypass.

Fig. 5 shows a two-compartment type prefilled syringe K2 according to a second embodiment of the present invention. The prefilled syringe K2 includes a bypass 26. The bypass 26 has one wall end 28 adjacent to the finger grip 11 and the other wall end 29 adjacent to the front sleeve 7. In the bypass 26, the peripheral wall of the cartridge 1 is bulged gradually radially outwardly further from the one end 28 towards the other end 29 such that a ratio of a cross-sectional area of the bypass 26 taken along a plane Y2 orthogonal to the axial direction of the cartridge 1 at the other wall end 29 to that taken along a plane Y1 orthogonal to the axial direction of the cartridge 1 at the one wall end 28 ranges from 1.2 to 5.0 approximately. Since other constructions of the prefilled syringe K2 are similar to those of the prefilled syringe K1, the description is abbreviated for the sake of brevity.

When the plunger rod 10 is depressed in the prefilled syringe K2, the third rubber stopper 12 is displaced forwardly towards the front sleeve 7 from the position shown by the broken line and occupies the position shown by the solid line as shown in Fig. 5. At this time, sealing property of the third rubber stopper 12 against the rear compartment 16 is cancelled, so that the dissolving agent 15 filled in the rear compartment 16 flows into the front compartment 14 via the bypass 26. Since flow rate of the dissolving agent 15 obtained by depression of the plunger rod 10 at this time is considered to be constant, flow velocity of the dissolving agent 15 is inversely proportional to cross-sectional area of the bypass 26. Therefore, flow velocity of the dissolving agent 15 is reduced at a ratio of 1.2 to 5.0 from the one wall end 28 to the other wall end 29 of the bypass 26. As will be seen from streamline of the dissolving agent 15 shown in Fig. 5, the dissolving agent 15 is diffused more at the other wall end 29 of the bypass 26 than at the one wall end 28 of the bypass 26 and flow velocity of the dissolving agent 15 is reduced from the one wall end 28 of the bypass 26 towards the other wall end 29 of the bypass 26, so that it is possible to prevent the squirt phenomenon in which the dissolving agent 15 is spouted into the front compartment 14 like a squirt.

The one wall end 28 of the bypass 26 is projected radially outwardly through a distance g from the peripheral wall of the cartridge 1, while the other wall end 29 of the bypass 26 is projected radially outwardly through a distance h from the peripheral wall of the cartridge 1. If a difference between the distance h and the distance g, i.e., (h - g) is selected in accordance with an interval between the planes Y1 and Y2, degree of change of flow velocity of the dissolving agent 15 can be set easily.

In the present invention, the bypass formed by radially outwardly bulging the portion of the peripheral wall of the cartridge disposed between the first rubber stopper and the third rubber stopper is shaped such that not only dimension of the one end of the bypass adjacent to the finger grip is minimized but dimension of the other end of the bypass adjacent to the front sleeve is increased.

Therefore, in accordance with the present invention, since vigor of the dissolving agent is diminished greatly by slight increase of volume of the bypass, the dissolving agent flows slowly and thus, the squirt phenomenon can be prevented.

Meanwhile, in accordance with the present invention, it is possible to eliminate such a risk that the dissolving agent flows directly into the injection needle together with air in the front compartment.

Furthermore, in accordance with the present invention, since a required amount of the dissolving agent can flow slowly into the medicament in the front compartment, excellent injection liquid can be obtained and amount of the dissolving agent left in the prefilled syringe after administration of the injection liquid can be minimized.

Claims

1. A two-compartment type prefilled syringe (K1) comprising:

   a cartridge (1);
   a front sleeve (7) which is mounted on a front end portion of the cartridge (1) and has an injection needle (3) mounted thereon;
   a first rubber stopper (6) which is fitted into the front sleeve (7) and is pierced through by the injection needle (3) prior to use of the prefilled syringe (K1);
   a second rubber stopper (9) which is fitted into a rear end portion of the cartridge (1);
   a plunger rod (10) which is attached to the second rubber stopper (9);

a third rubber stopper (12) which is fitted into the cartridge (1) so as to be disposed between the first rubber stopper (6) and the second rubber stopper (9) such that interior of the cartridge (1) is hermetically divided into a front compartment (14) defined between the first rubber stopper (6) and the third rubber stopper (12) and a rear compartment (16) defined between the third rubber stopper (12) and the second rubber stopper (9); and

a bypass (18) which is formed by radially outwardly bulging a portion of a peripheral wall of the cartridge (1) disposed between the first rubber stopper (6) and the third rubber stopper (12);

wherein in an axial direction of the cartridge (1), a length (20) of the third rubber stopper (12) is slightly smaller than an inner length (19) of the bypass (18);

wherein when the third rubber stopper (12) has been displaced into the bypass (18), sealing property of the rear compartment (16) against the front compartment (14) is cancelled such that dissolving agent (15), suspension or the like in the rear compartment (16) is carried, via the bypass (18), into the front compartment (14) containing dry medicament (13) or the like;

wherein a ratio (R) of a maximum width (b) of one end of the bypass (18) adjacent to the front sleeve (7) to a maximum width (a) of the other end of the bypass (18) adjacent to the rear end portion of the cartridge (1) is set to range from 1.2 to 5.0.

2. A two-compartment type prefilled syringe (K1) comprising:

a cartridge (1);
a front sleeve (7) which is mounted on a front end portion of the cartridge (1) and has an injection needle (3) mounted thereon;
a first rubber stopper (6) which is fitted into the cartridge (1) in the vicinity of the front sleeve (7);
a second rubber stopper (9) which is fitted into a rear end portion of the cartridge (1);
a plunger rod (10) which is attached to the second rubber stopper (9);
a third rubber stopper (12) which is fitted into the cartridge (1) so as to be disposed between the first rubber stopper (6) and the second rubber stopper (9) such that interior of the cartridge (1) is hermetically divided into a front compartment (14) defined between the first rubber stopper (6) and the third rubber stopper (12) and a rear compartment (16) defined between the third rubber stopper (12) and the second rubber stopper (9); and

a bypass (18) which is formed by radially outwardly bulging a portion of a peripheral wall of the cartridge (1) disposed between the first rubber stopper (6) and the third rubber stopper (12);

wherein in an axial direction of the cartridge (1), a length (20) of the third rubber stopper (12) is slightly smaller than an inner length (19) of the bypass (18);

wherein when the third rubber stopper (12) has been displaced into the bypass (18), sealing property of the rear compartment (16) against the front compartment (14) is cancelled such that dissolving agent (15), suspension or the like in the rear compartment (16) is carried, via the bypass (18), into the front compartment (14) containing dry medicament (13) or the like;

wherein at an initial stage of depression of the plunger rod (10), the first rubber stopper (6) is displaced into the front sleeve (7) such that the front compartment (14) and the injection needle (3) are communicated with each other;

wherein a ratio (R) of a maximum width (b) of one end of the bypass (18) adjacent to the front sleeve (7) to a maximum width (a) of the other end of the bypass (18) adjacent to the rear end portion of the cartridge (1) is set to range from 1.2 to 5.0.

3. A two-compartment type prefilled syringe (K1) as claimed in Claim 1, wherein opposite side edges (21) of the bypass (18) connecting the one end and the other end of the bypass (18) are formed rectilinearly.

4. A two-compartment type prefilled syringe (K1) as claimed in Claim 2, wherein opposite side edges (21) of the bypass (18) connecting the one end and the other end of the bypass (18) are formed rectilinearly.

5. A two-compartment type prefilled syringe (K1') as claimed in Claim 1, wherein each of opposite side edges (23) of the bypass (22) connecting the one end and the other end of the bypass (22) is formed by a gentle convex arc.

6. A two-compartment type prefilled syringe (K1') as claimed in Claim 2, wherein each of opposite side edges (23) of the bypass (22) connecting the one end and the other end of the bypass (22) is formed by a gentle convex arc.

7. A two-compartment type prefilled syringe (K1") as claimed in Claim 1, wherein each of opposite side edges (25) of the bypass (24) connecting the one end and the other end of the bypass (24) is formed

by a gentle concave arc.

8. A two-compartment type prefilled syringe (K1") as claimed in Claim 2, wherein each of opposite side edges (25) of the bypass (24) connecting the one end and the other end of the bypass (24) is formed by a gentle concave arc.

9. A two-compartment type prefilled syringe (K2) comprising:

a cartridge (1);
a front sleeve (7) which is mounted on a front end portion of the cartridge (1) and has an injection needle (3) mounted thereon;
a first rubber stopper (6) which is fitted into the front sleeve (7);
a second rubber stopper (9) which is fitted into a rear end portion of the cartridge (1);
a plunger rod (10) which is attached to the second rubber stopper (9);
a third rubber stopper (12) which is fitted into the cartridge (1) so as to be disposed between the first rubber stopper (6) and the second rubber stopper (9) such that interior of the cartridge (1) is hermetically divided into a front compartment (14) defined between the first rubber stopper (6) and the third rubber stopper (12) and a rear compartment (16) defined between the third rubber stopper (12) and the second rubber stopper (9); and
a bypass (26) which is formed by radially outwardly bulging a portion of a peripheral wall of the cartridge (1) disposed between the first rubber stopper (6) and the third rubber stopper (12);

wherein in an axial direction of the cartridge (1), a length (20) of the third rubber stopper (12) is slightly smaller than an inner length (19) of the bypass (26);

wherein when the third rubber stopper (12) has been displaced into the bypass (26), sealing property of the rear compartment (16) is cancelled such that dissolving agent (15), suspension or the like in the rear compartment (16) is carried, via the bypass (26), into the front compartment (14);

wherein the portion of the peripheral wall of the cartridge (1) rises gradually radially outwardly further from one end (28) of the bypass (26) adjacent to the rear end portion of the cartridge (1) towards the other end (29) of the bypass (26) adjacent to the front sleeve (7) such that a ratio of a cross-sectional area of the bypass (26) taken along a plane (Y2) orthogonal to the axial direction of the cartridge (1) at the other end (29) of the bypass (26) to that taken along a plane (Y1) orthogonal to the axial direction of the cartridge (1) at the one end (28) of the bypass (26) ranges from 1.2 to 5.0.

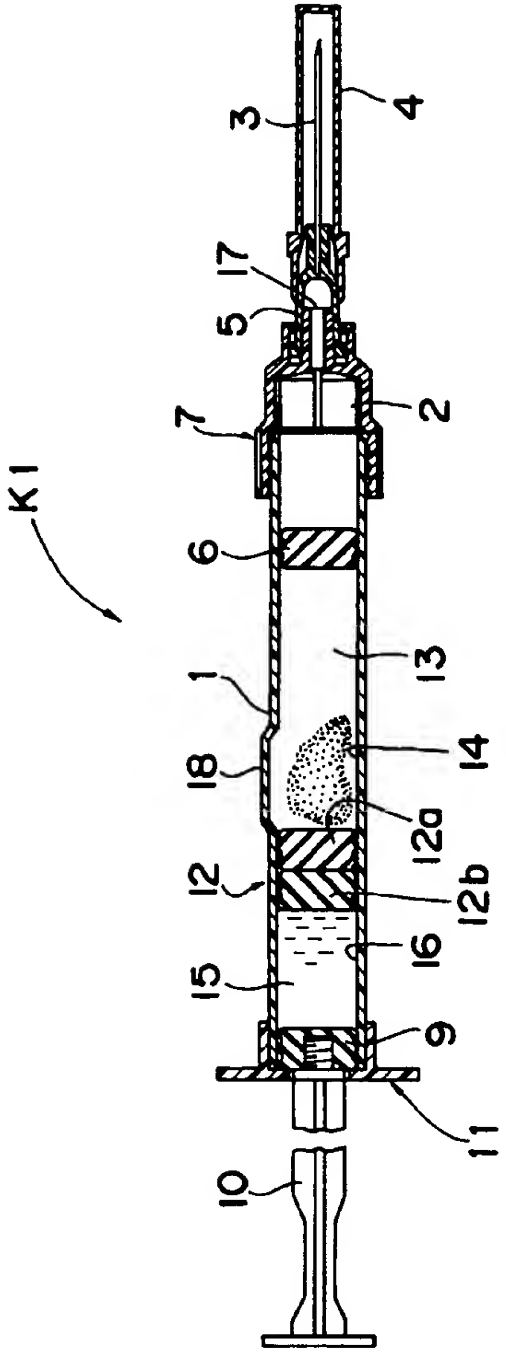


Fig. 1

Fig. 2

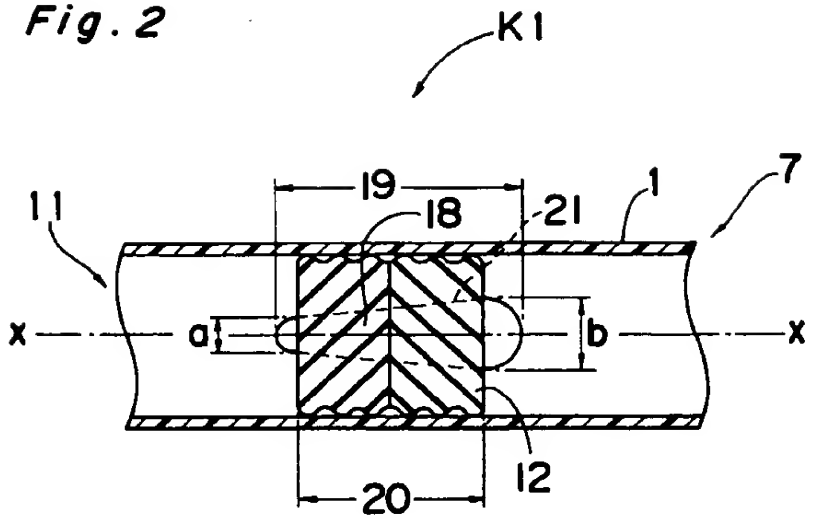


Fig. 3

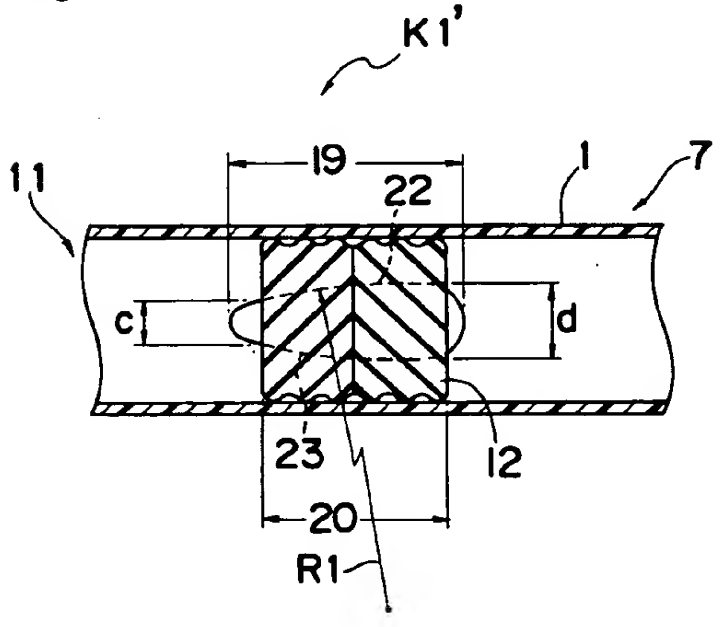


Fig. 4

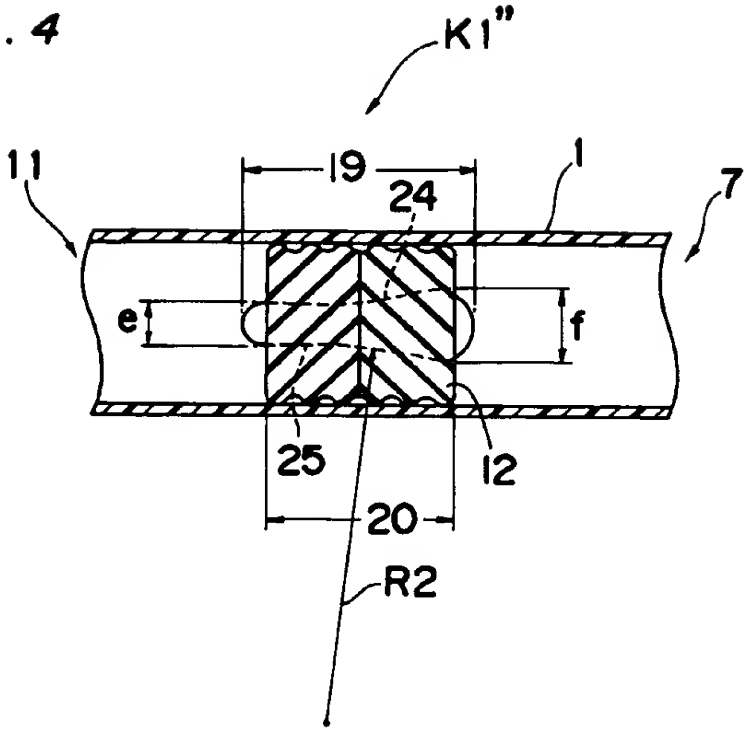
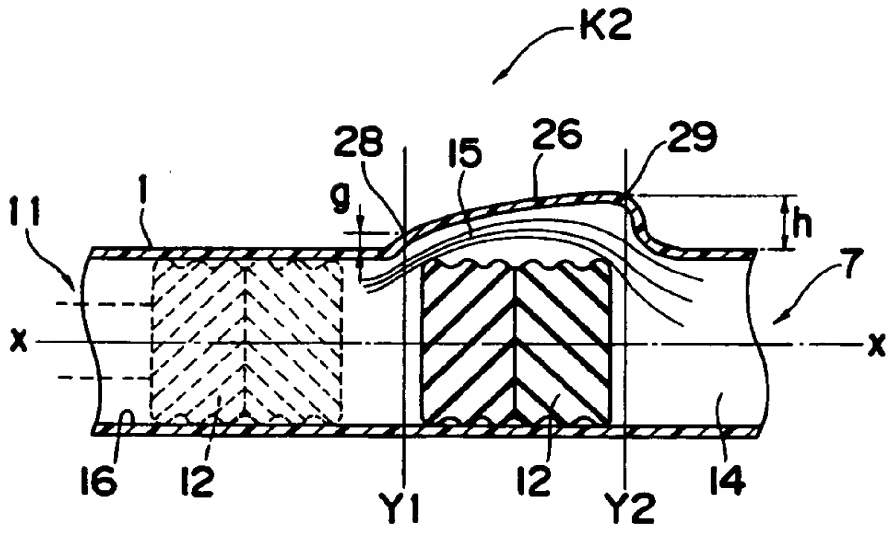

K1"
11
19
24
1
7
e
f
25
12
20
R2

Fig. 5


K2
28
15
26
29
11
1
g
h
7
x
x
16
12
Y1
12
Y2
14

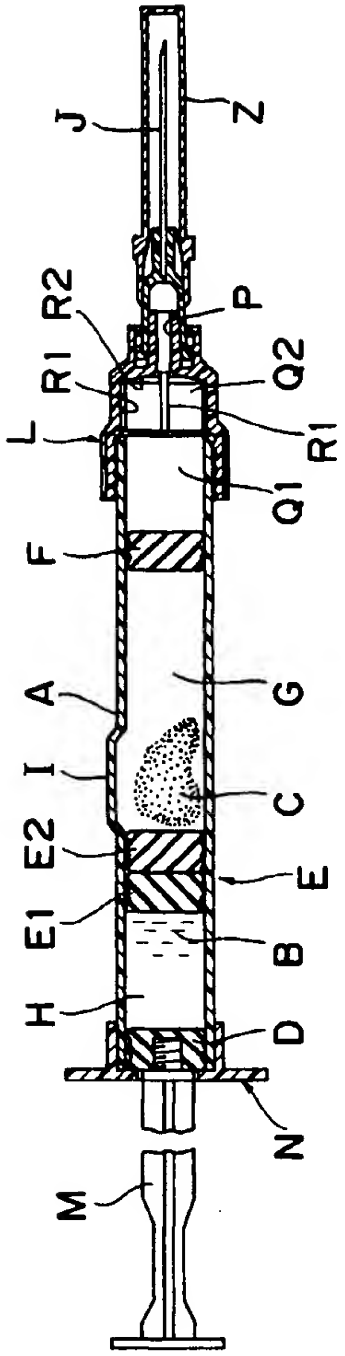


Fig.6 PRIOR ART

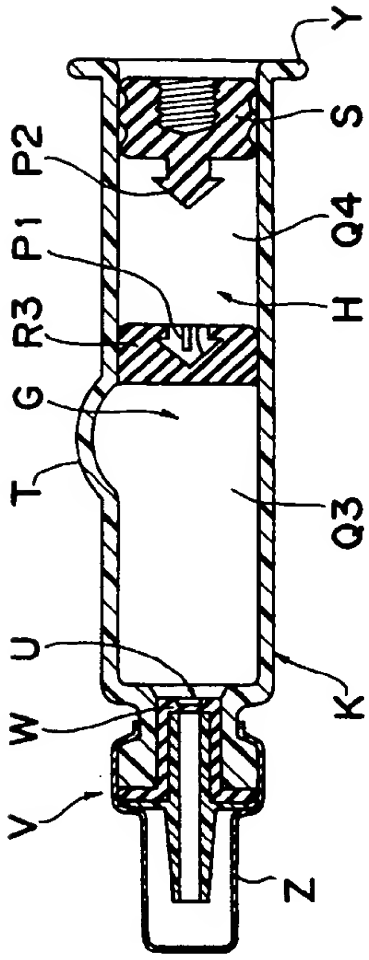


Fig. 7 PRIOR ART